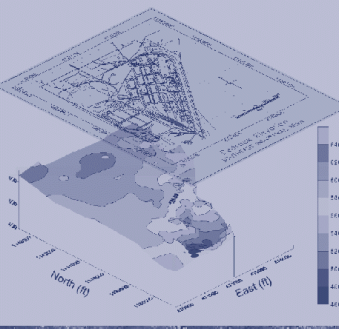
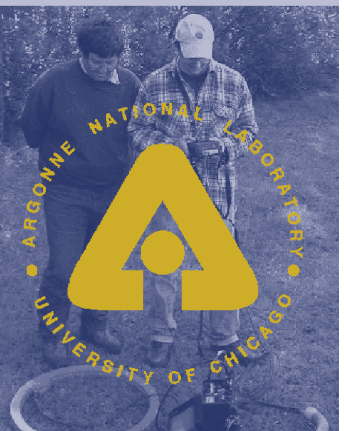




GEOPHYSICS IN CANTONMENT AREAS

Seismic Case Studies:

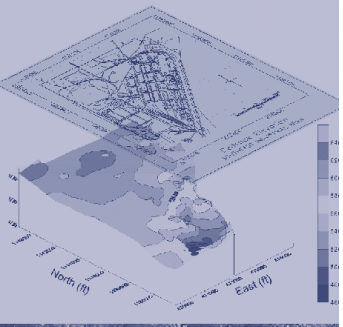
Anniston Army Depot

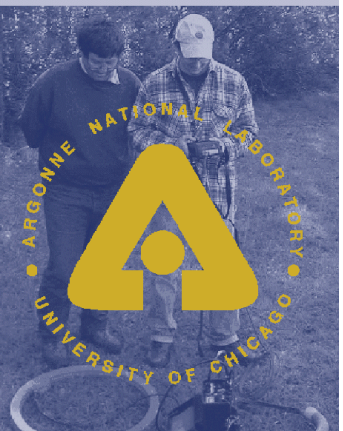
Fort Campbell

By:

M.D. Thompson (ANL), W.A. Mandell (AEC)

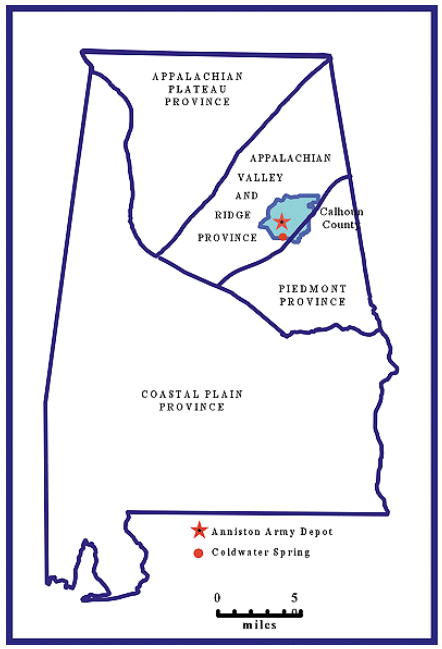
S.F. Miller (ANL), J.M. Cooper (ANL)





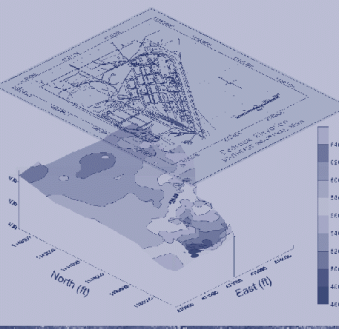
Site Locations

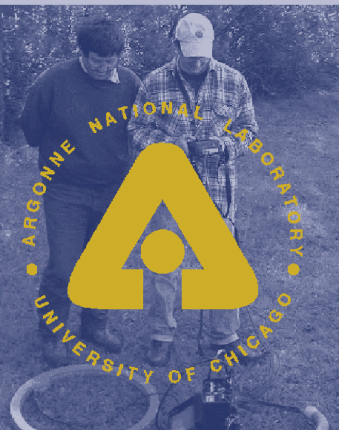
- ANAD



FTC

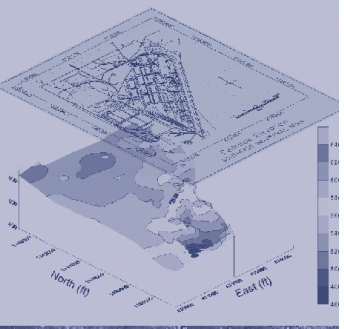
- Karst Geology
- DNAPL and LNAPL Contaminants
- Industrial Area & Active Airfield

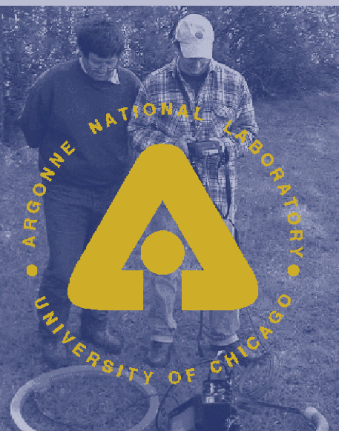




Overview

- **Issues Goals**
- **Methodology**
- **Case Studies**
  - **Anniston Army Depot (ANAD)**
  - **Campbell Army Airfield (CAAF)**
- **Conclusions**

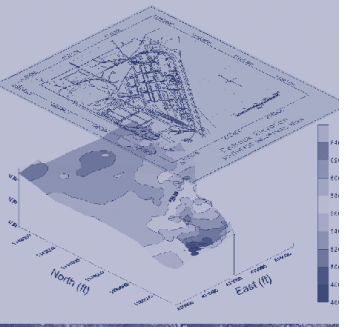


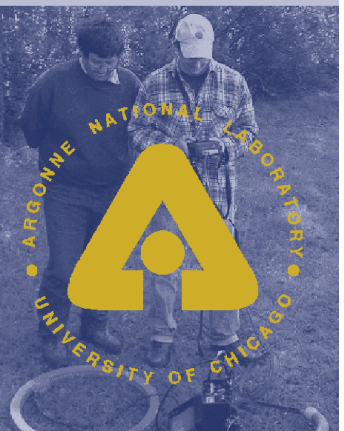


Concerns & Issues

- LNAPL (fuels) & DNAPL (solvents)
  - Spiller, dumped, and are still in use. Where did they go and where did they come from?
- Technical Feasibility
  - Once found, can they be remediated
- Other Environmental Impacts
  - Land stewardship, land use
- COSTS
  - Your'e taking bullets from my troops

U.S. ARMY ENVIRONMENTAL CENTER
USAEC

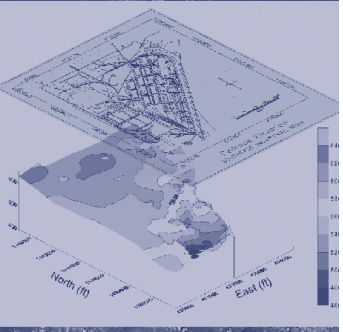


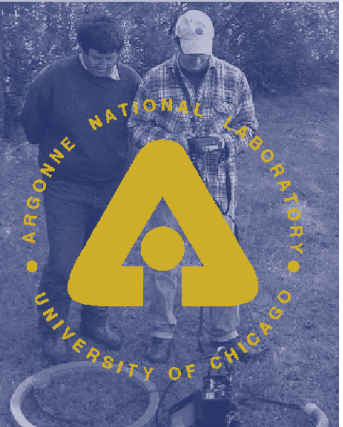


General Goals

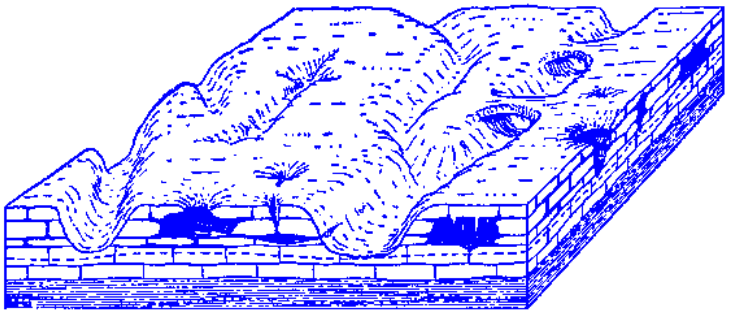
- **Ideal Description of Karst**
- **Reduce Drilling and Investigative Costs**
- **Verification of Geotechnical Models**

Ideal Description of Karst

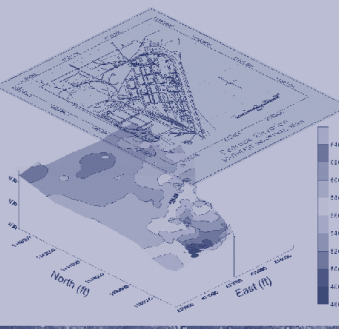


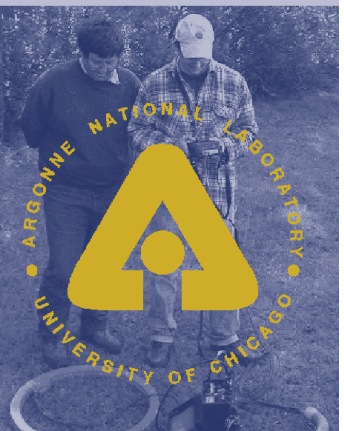


- Fracture and Void Systems
- Bedding Planes



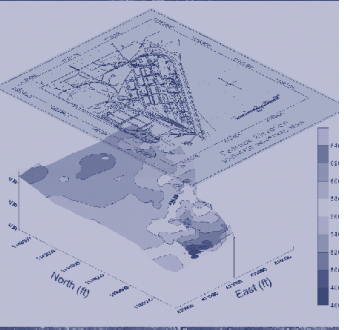
- W es
- Routes of Entry and Exit

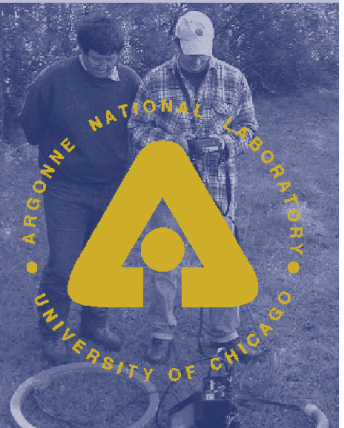




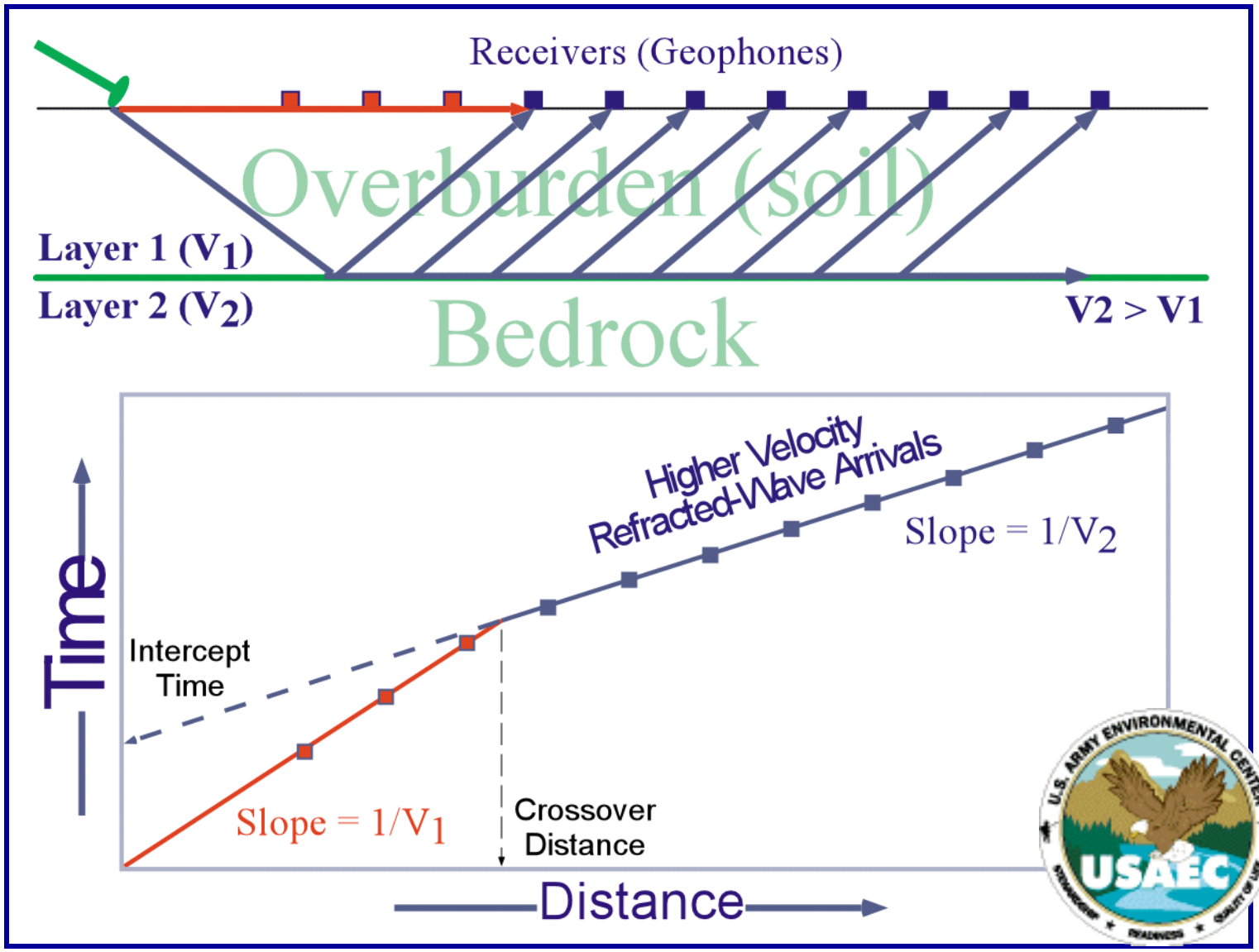
Geophysical Methods

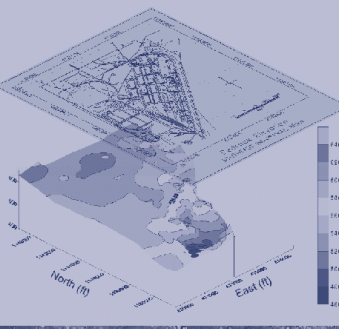
- **Seismic Refraction**
  - Top of “competent” bedrock
  - Top of epikarst?
  - Top of Saturated zone?
- **2D Resistivity Tomography**
  - Top of bedrock and epikarst
  - Bedrock fractures and cavities
- **EM Terrain-Conductivity**
  - Clay-filled fracture systems
- **Downhole Surveys**
  - Constrain surface models

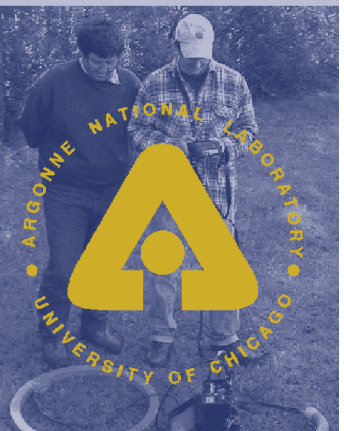




Refraction Method

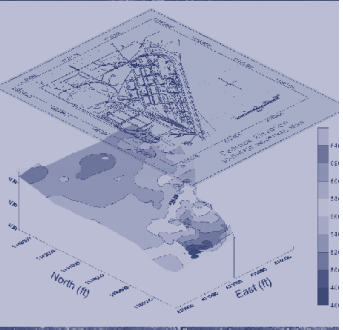


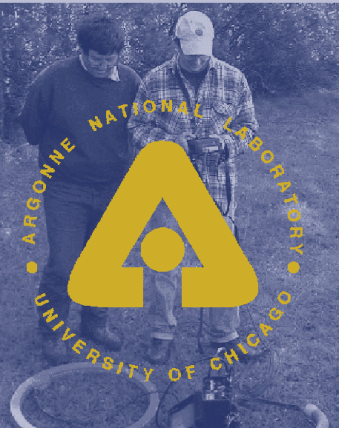




Refraction Targets

- **Bedrock Surface**
  - **Changes in Topography**
  - **Pinnacles, Depressions**
- **Velocity Changes**
  - **Weak/Competent Zones**
  - **Fractured Intervals**

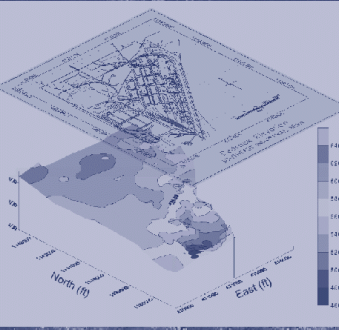


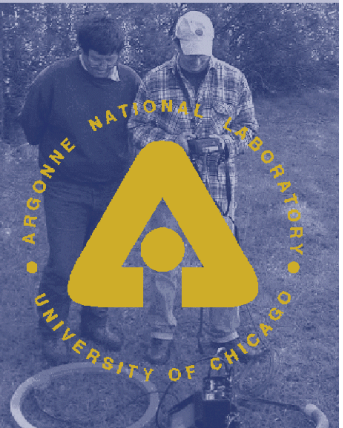


Refraction: Road Blocks

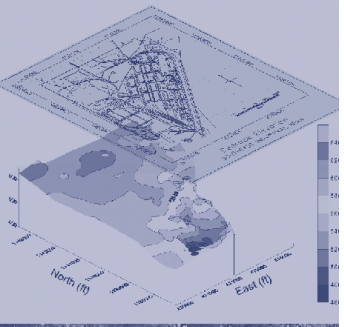
- **Noisy Environment**
  - **Sumps, Fans, Traffic**
- **Difficult Medium**
  - **Road/Foundation Design**
  - **Low Signal Levels**
- **Complex Geology**

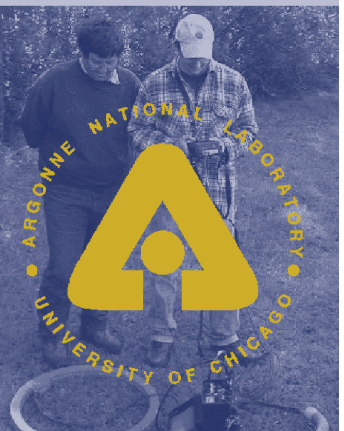
Refraction: Solutions





- **Brute Force**
  - **High-energy Sou**
- **Survey Design**
  - **Source Location**
  - **Receiver-Ground Coupling**
  - **Target Parameters**
  - **Modify Instrumentation**
  - **Work Off Hours**

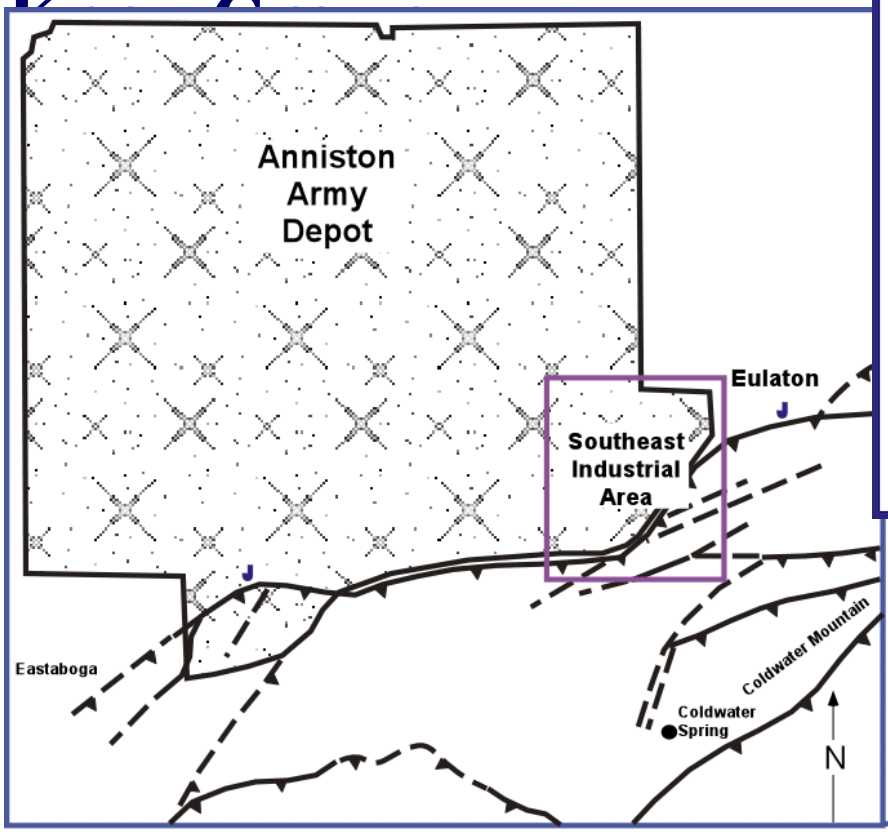


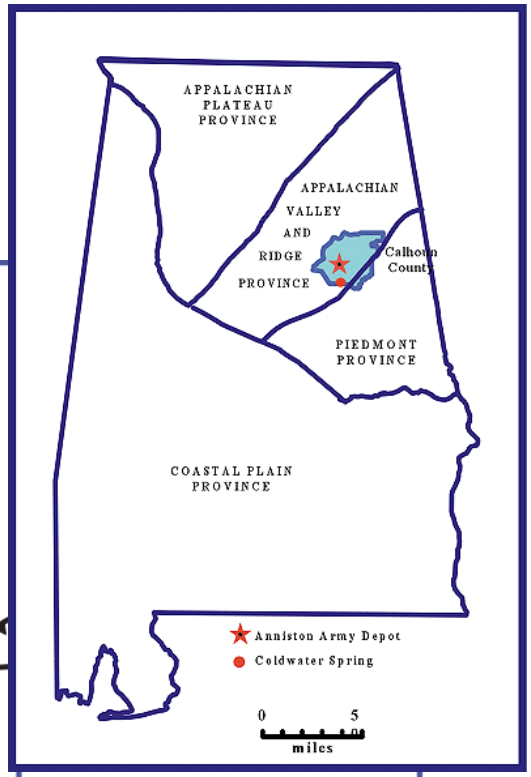


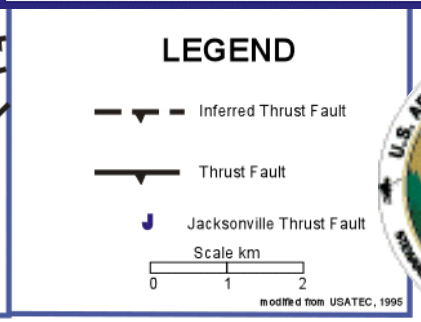
Anniston Army Depot

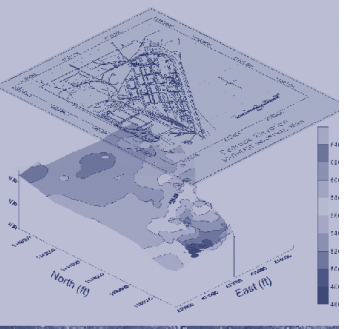
Valley and Ridge Province

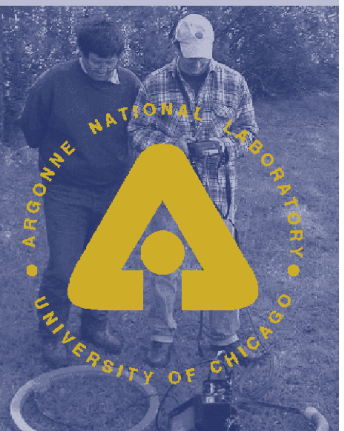
Thrust Faulted Area





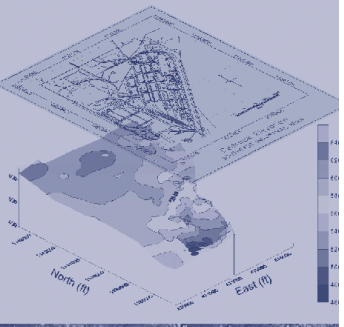


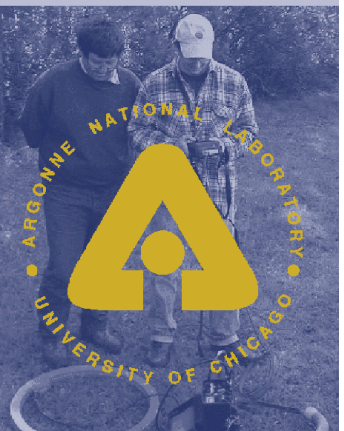




ANAD: Geology

- **Knox Gp. Dolomites**
  - **Karst, Developed Void System**
- **Structural Setting**
  - **Jacksonville Thrust Fault**
  - **Folded/Tilted Strata**
- **Complex Geology**
  - **Fractured Rock**

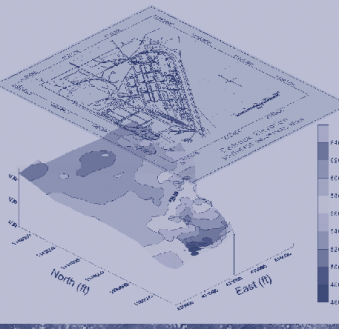


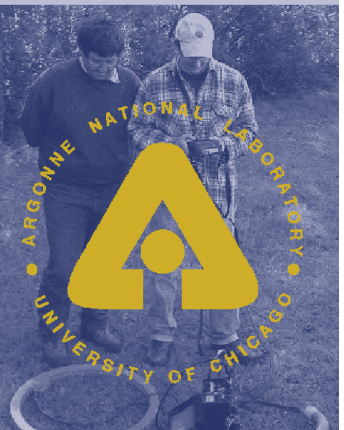


ANAD: Problems

- **TCE and Chrome Contamination**
- **Monitoring wells were set based on auger refusal**
- **Heavily fractured rock**
- **Groundwater controlled by geologic structure?**

ANAD: Refraction Surveys

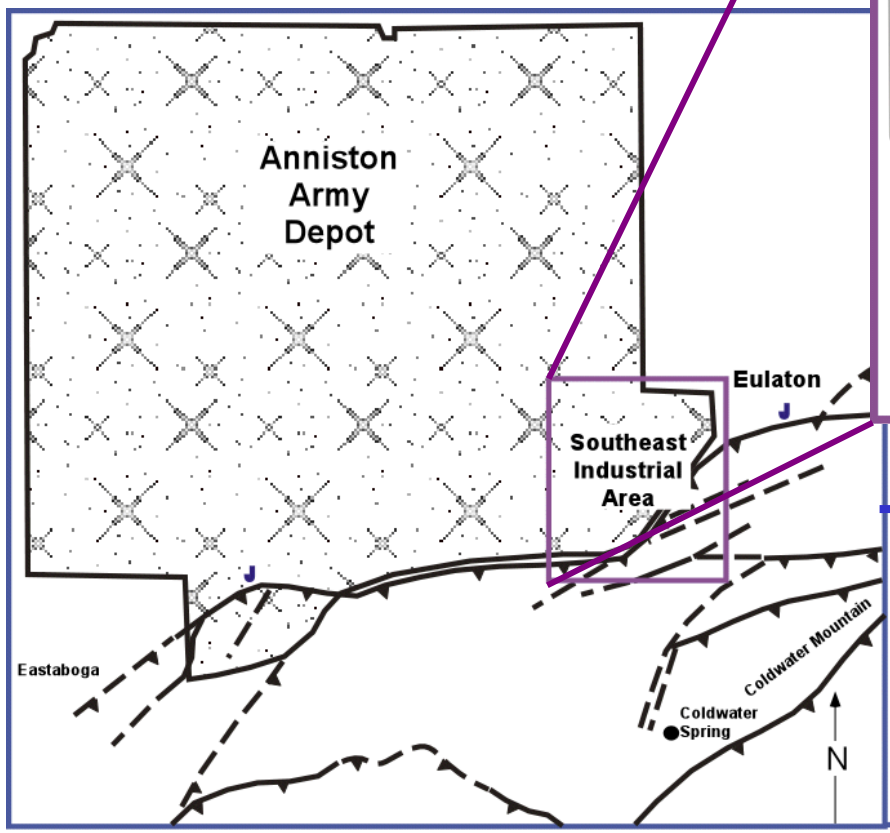


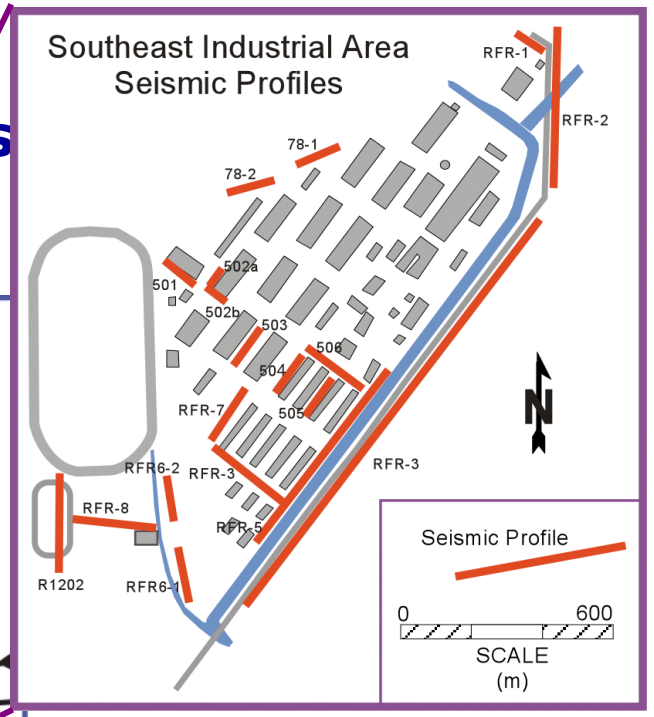


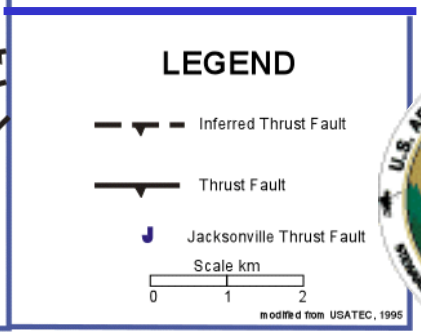
Data Acquired in the SIA

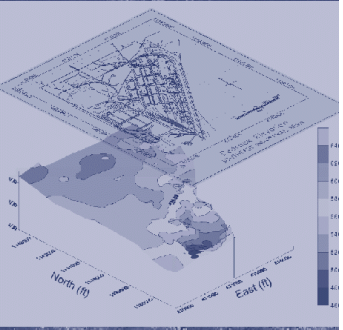
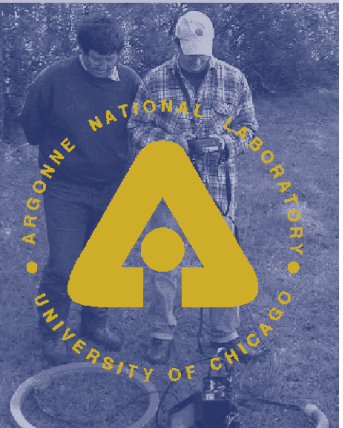
Augment Existing Borings

Bedrock Topography

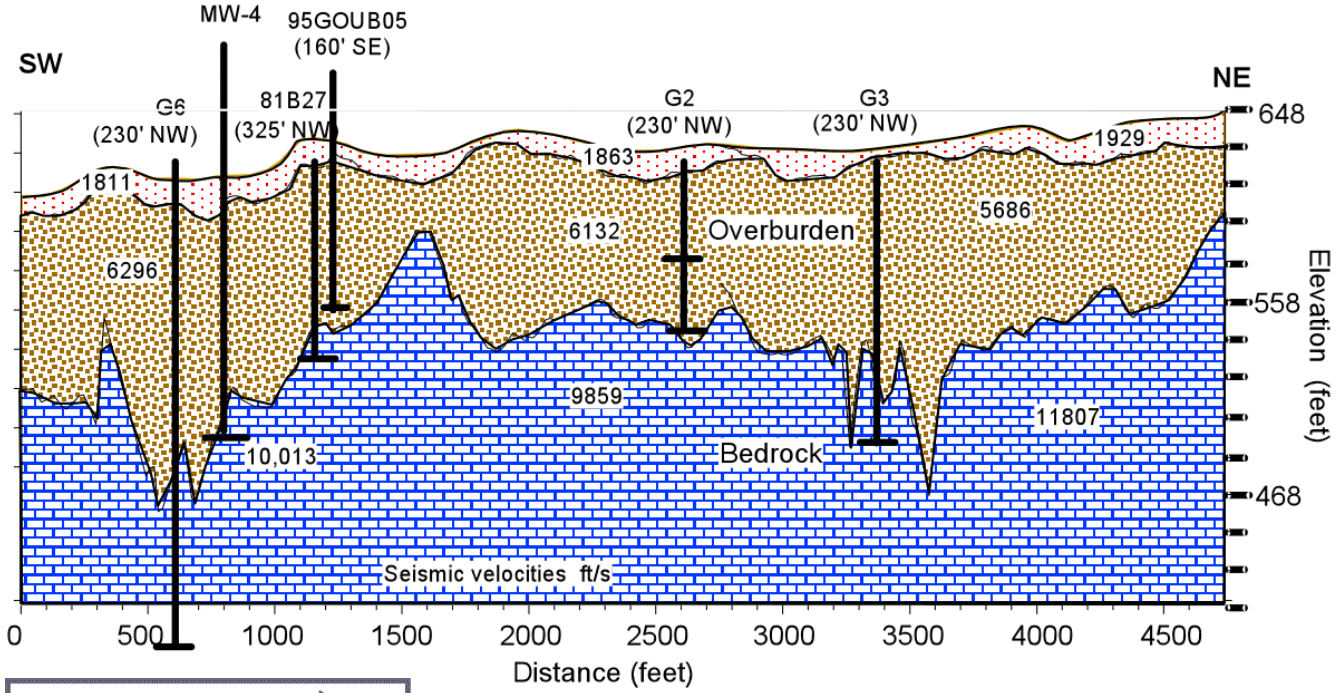


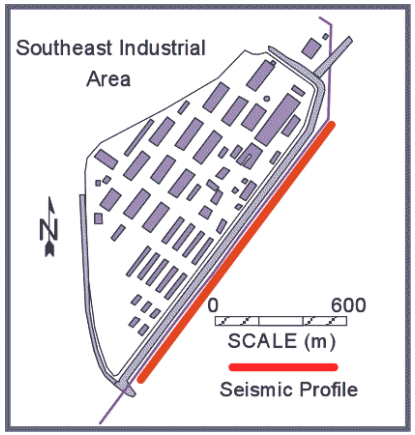




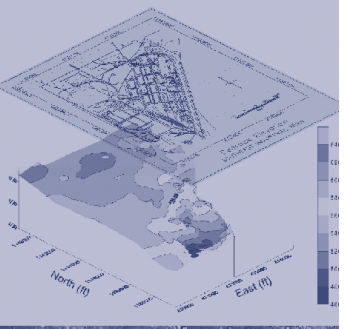
SE Boundary Profile

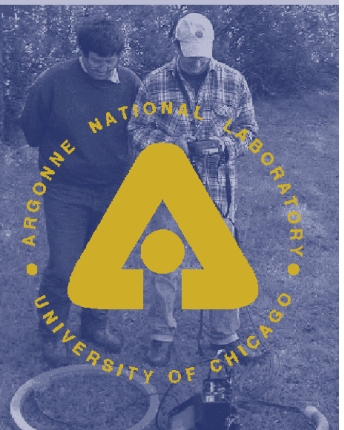


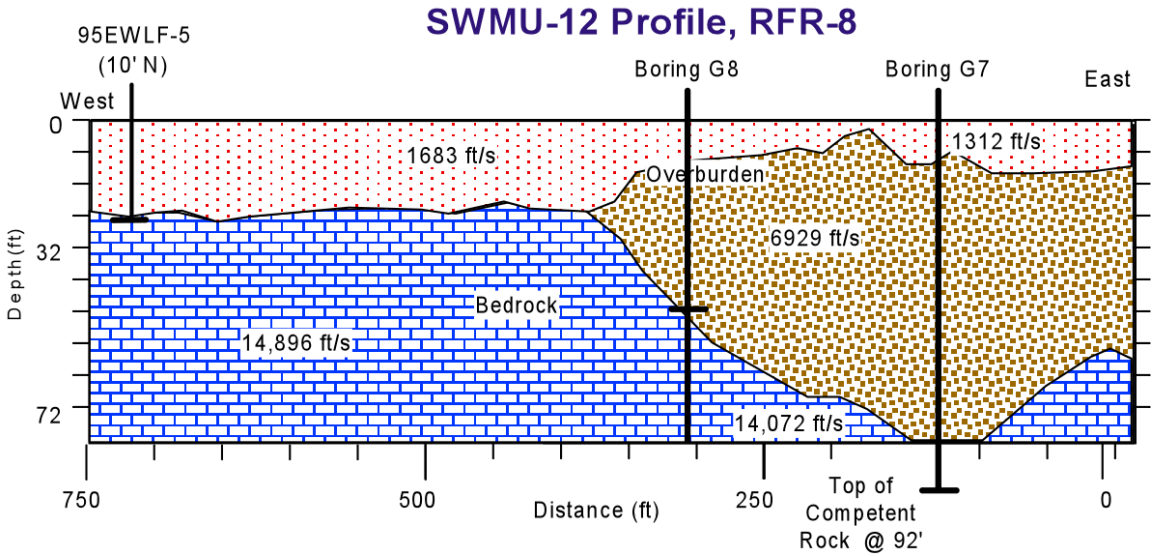


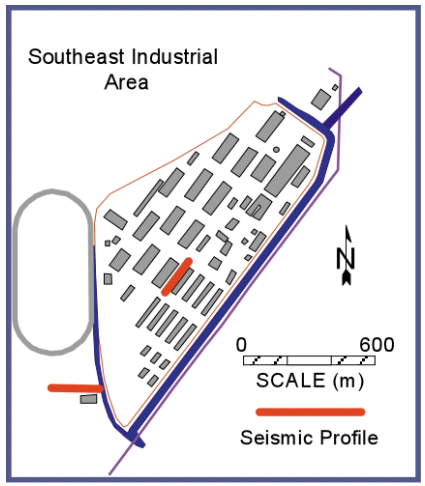
Borehole: horizontal bar indicates top of bedrock. For hole G2, upper horizontal bar indicates top of 15-20 ft thick dolomite layer.

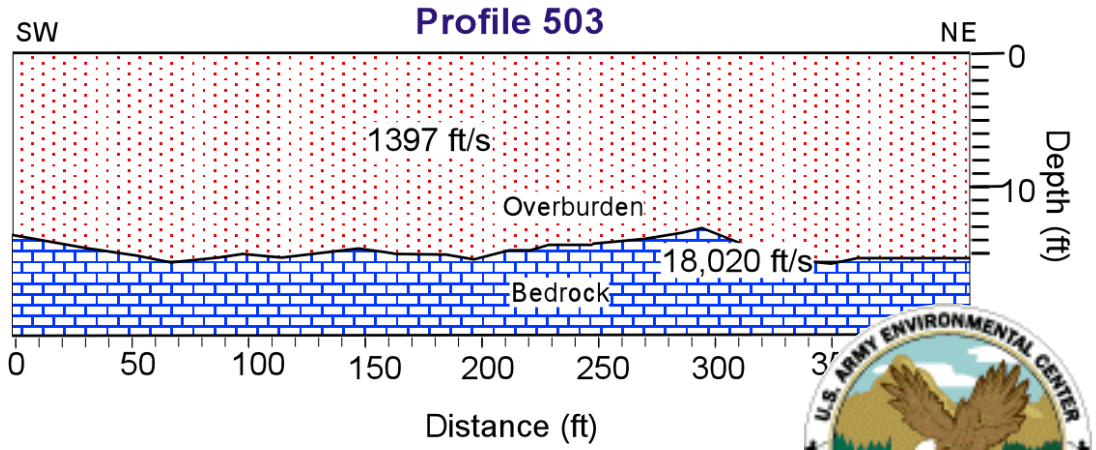
ANAD: Refraction Surveys

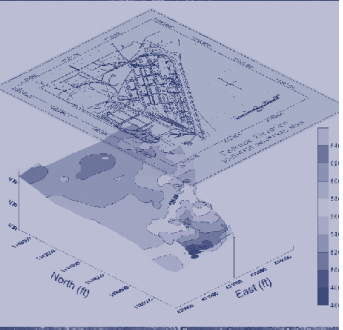


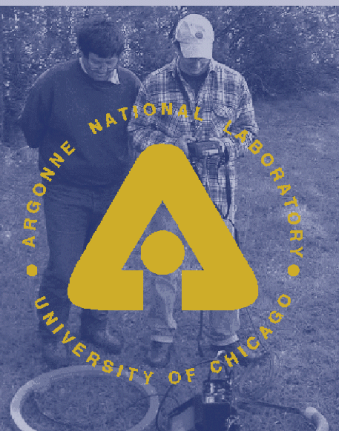




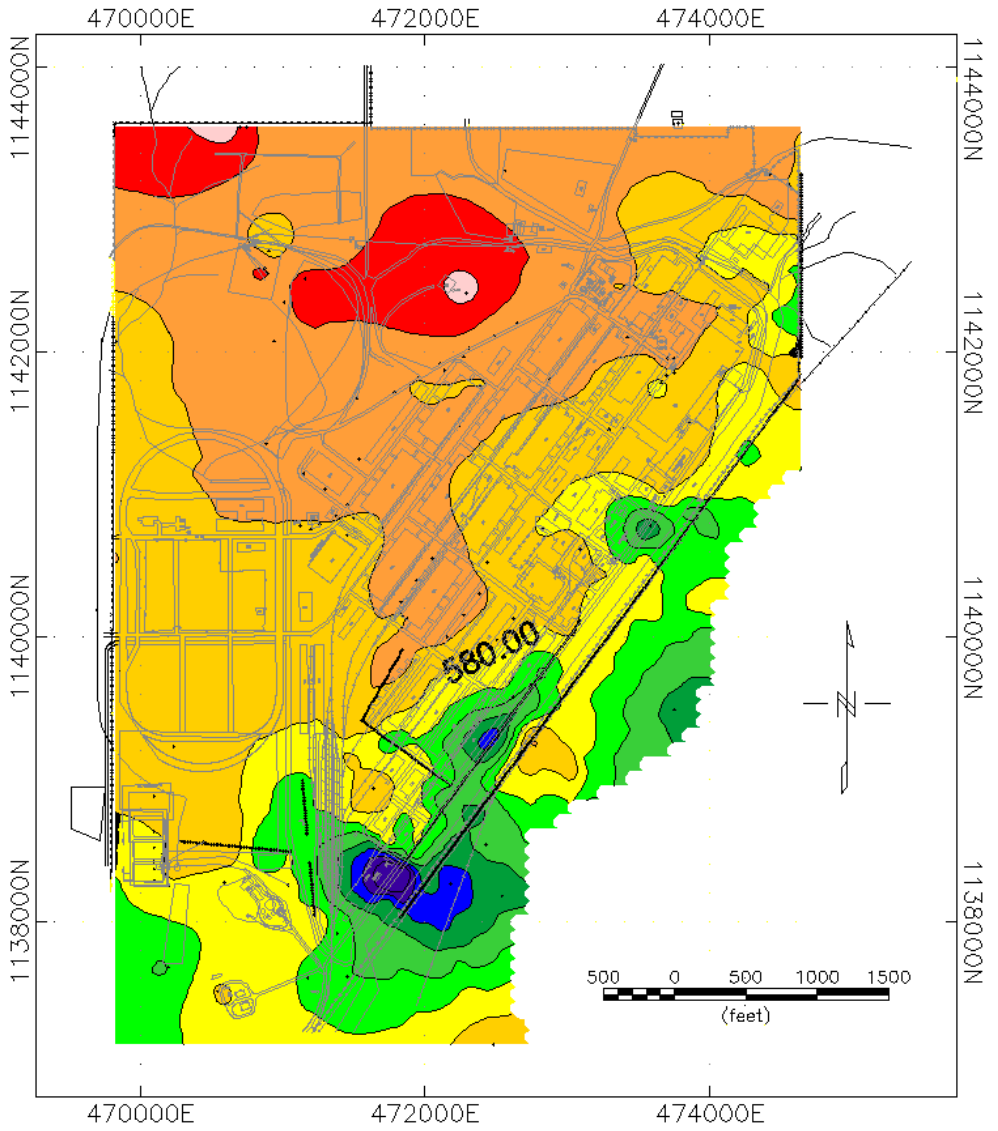


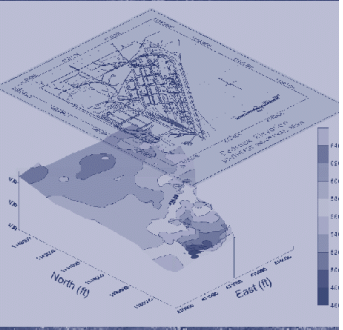


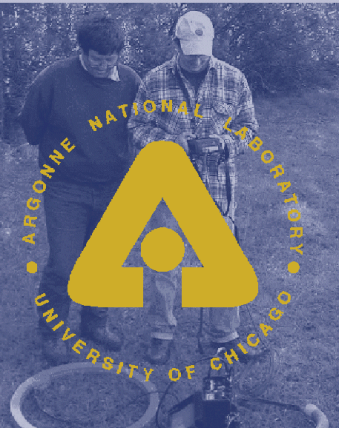




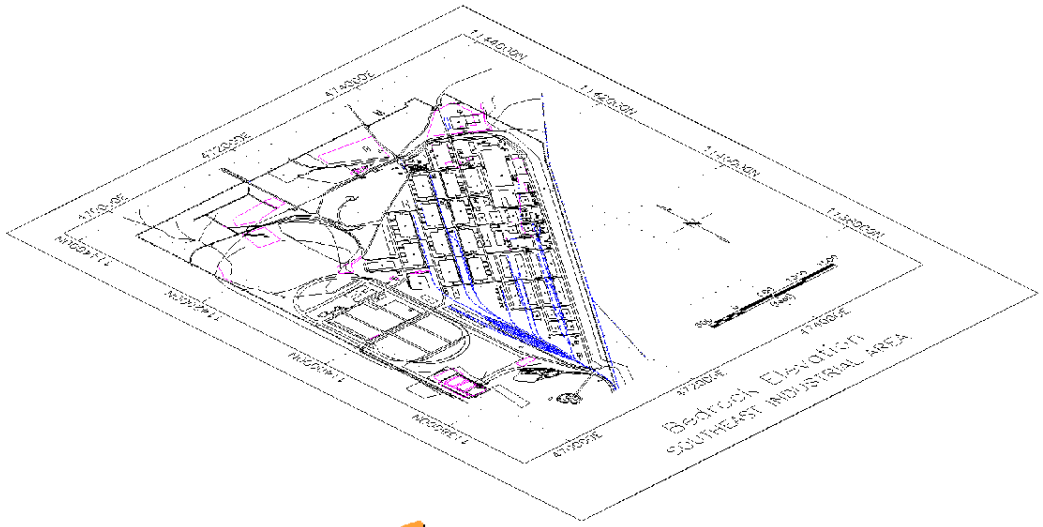
ANAD: Bedrock Surface

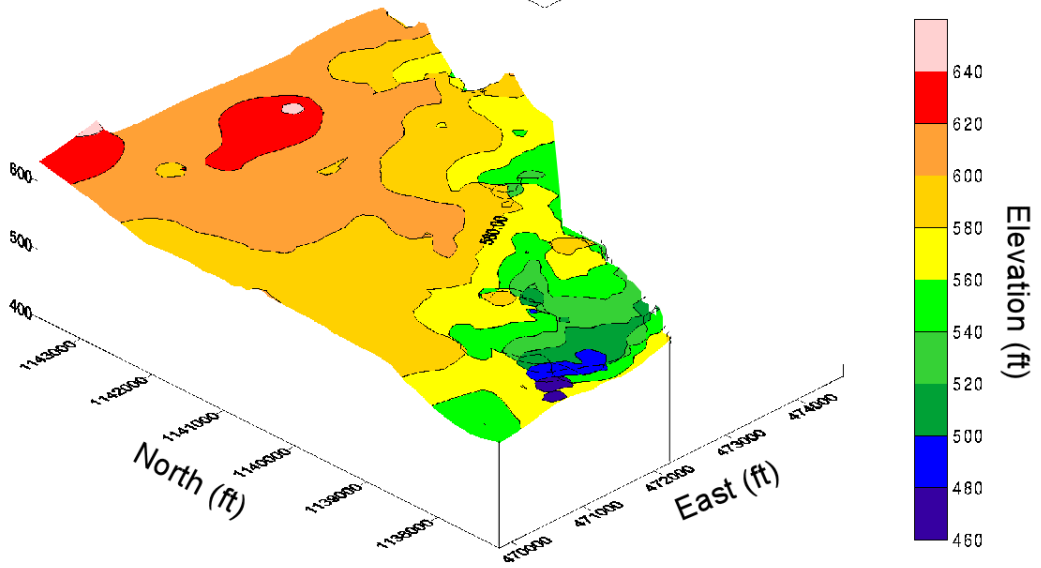


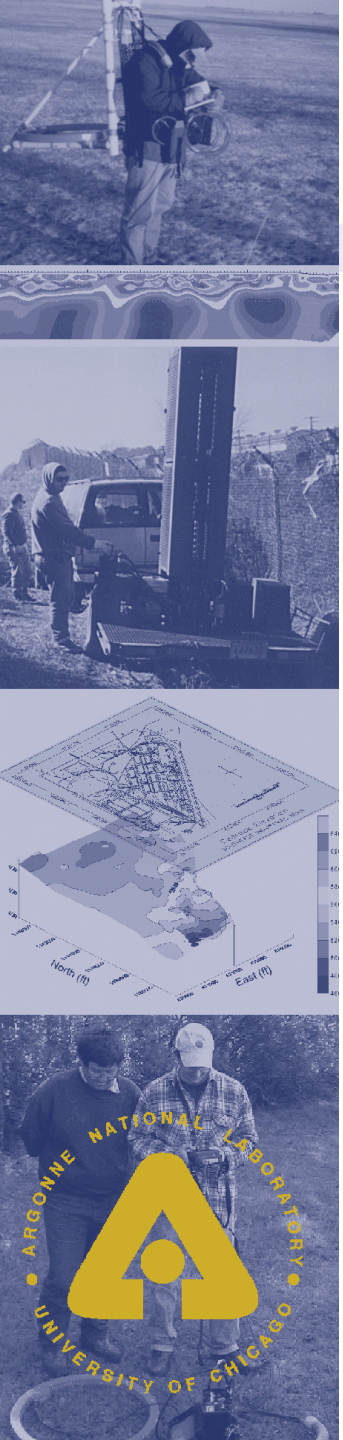




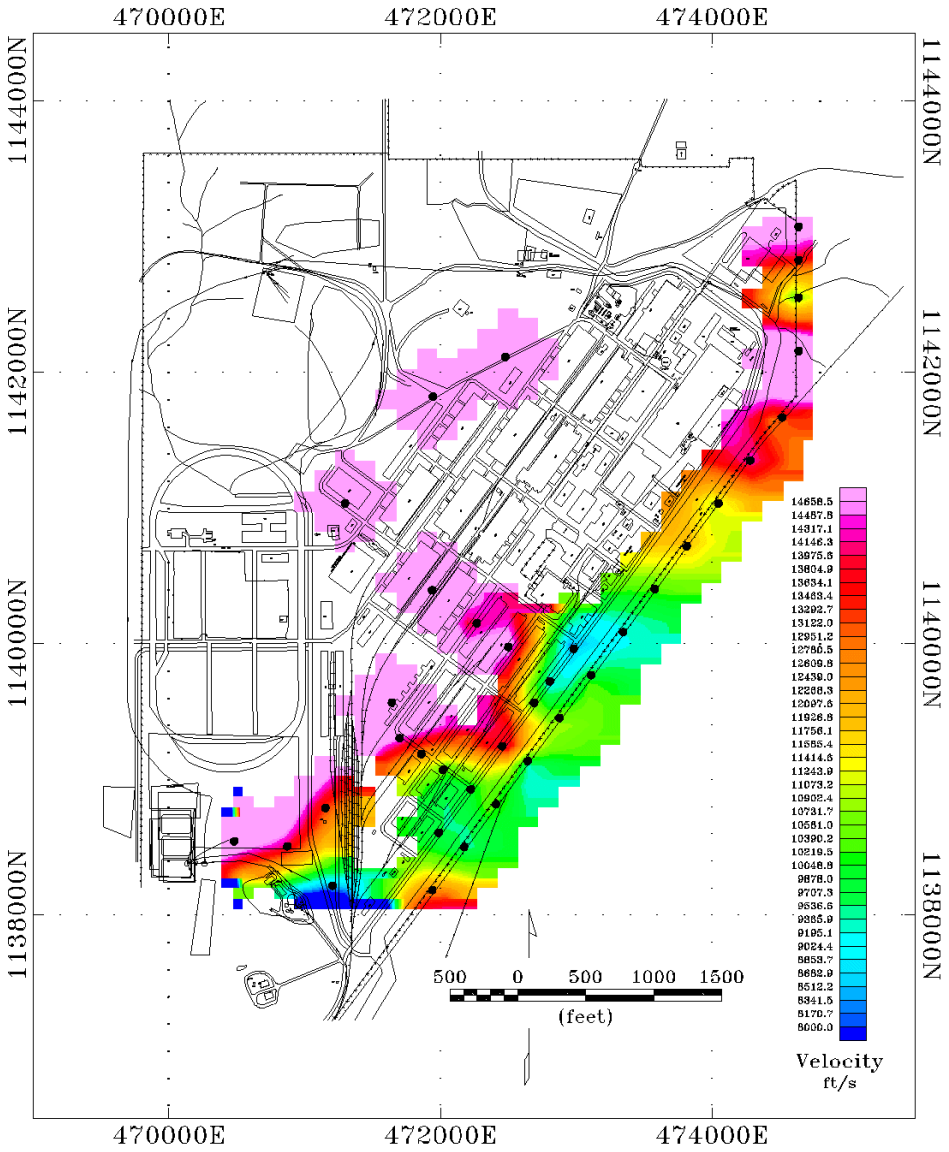
ANAD: Bedrock Surface



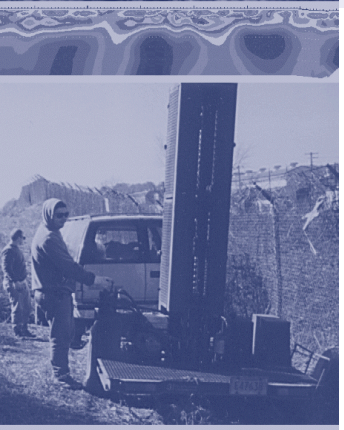


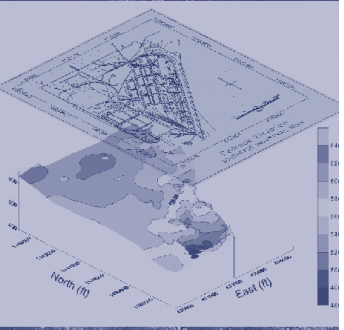


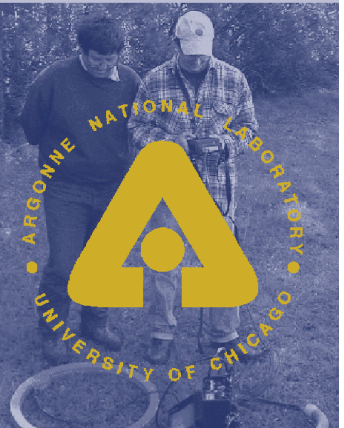
ANAD: Bedrock Velocity

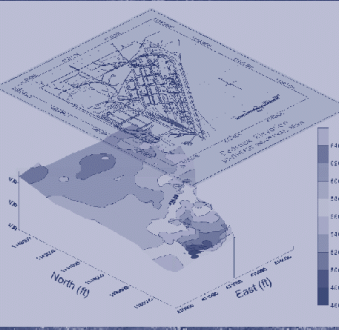


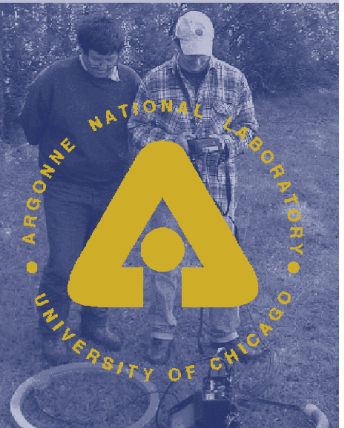
Fort Campbell: CAAF Views



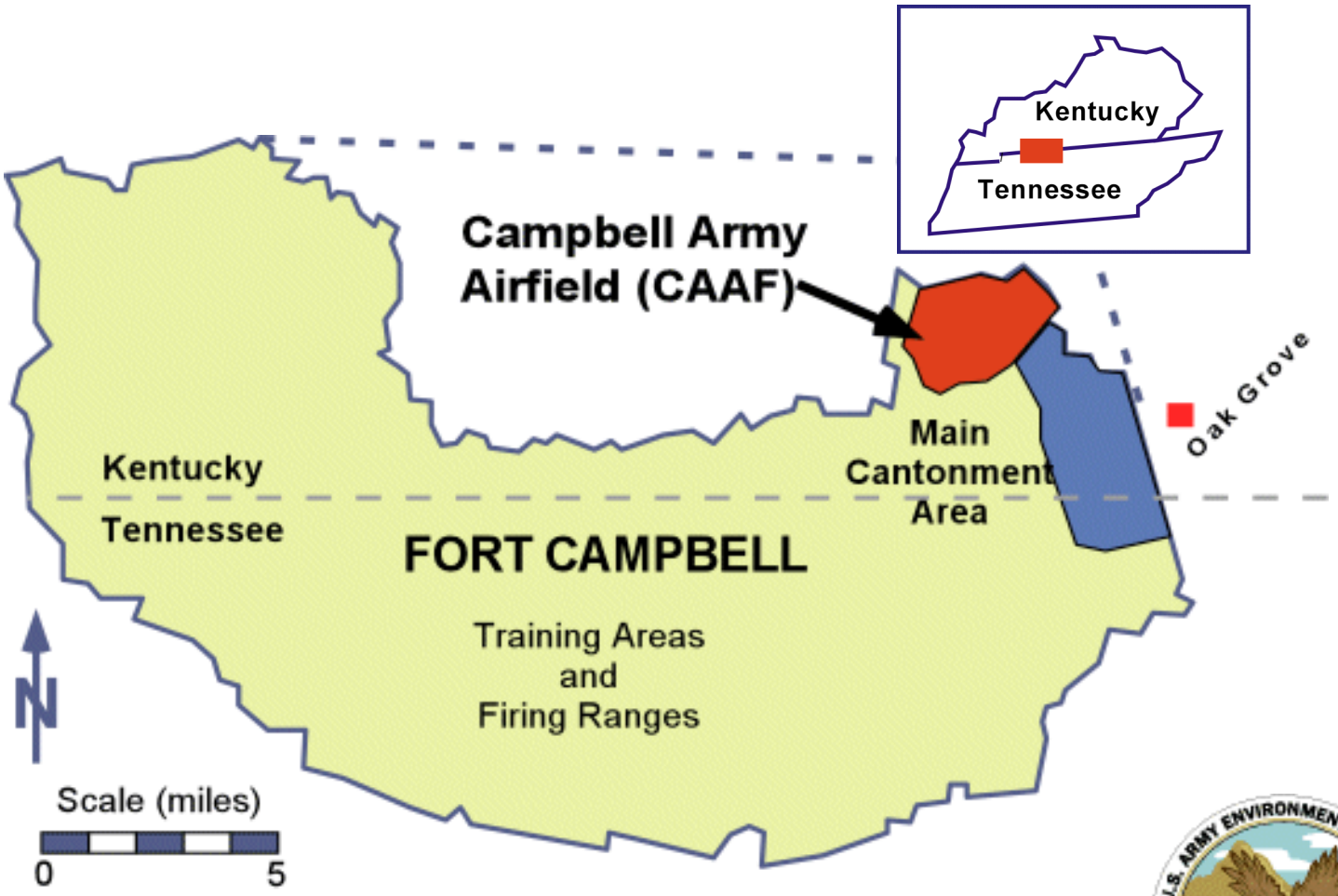


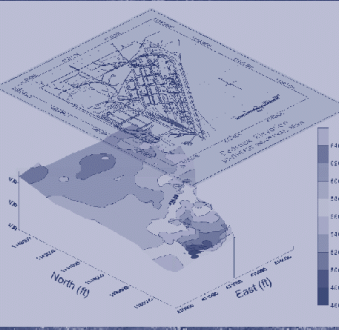


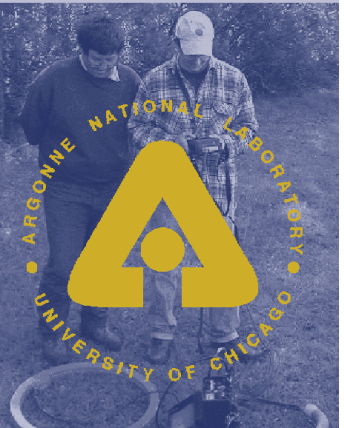




Fort Campbell

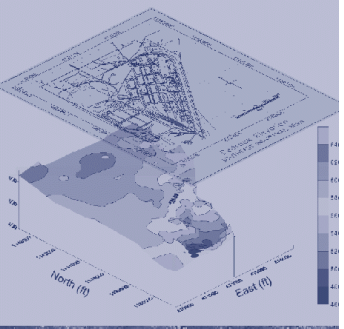


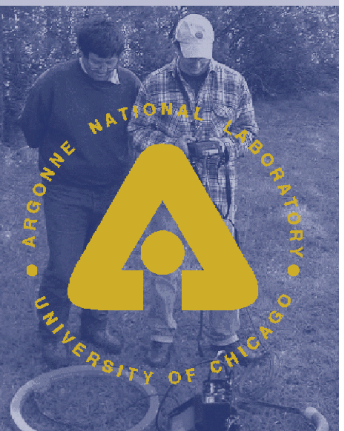




Fort Campbell: Geology

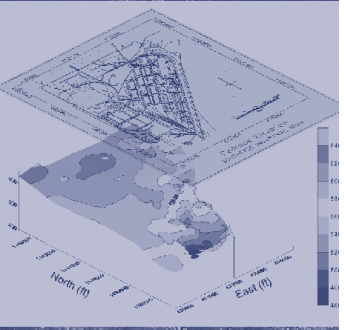
- **St. Louis Limestone**
  - **Remnants of St. Genevieve**
  - **Cavity/Void Development**
- **Structural Setting**
  - **Horizontal Strata**
  - **Minor Faulting**
- **Karst System**

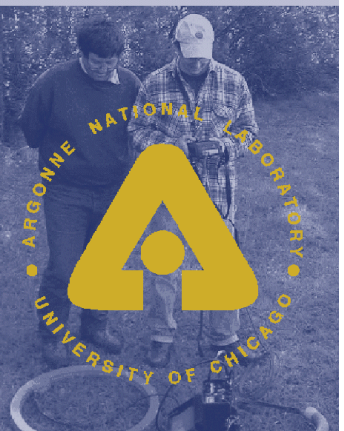




Fort Campbell: Objectives

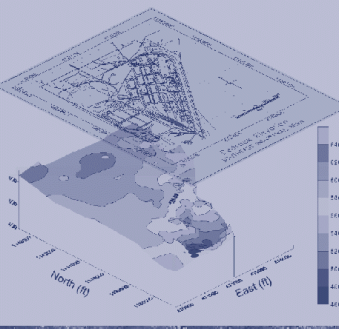
- **Map the Bedrock Surface**
- **Locate Fractures Zones**
- **Refine the Geologic Framework**
- **Provide Support Information**

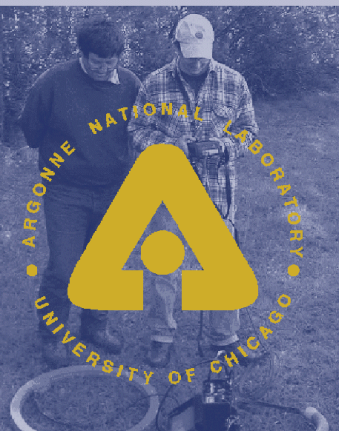




Fort Campbell: Problems

- **Jet Fuels (JP-4) Spilled**
  - **Don’t know where fuel went!**
- **Solvents in Sub-surface?**
- **Carbonate Bedrock**
  - **Fractured & Cavernous Carbonate**
  - **Weathered Zone**

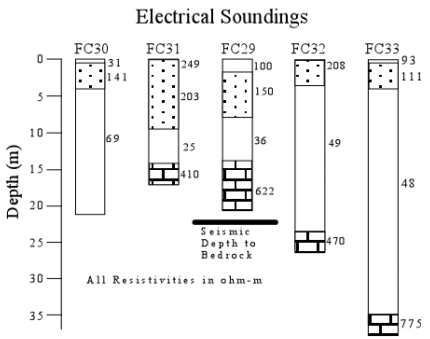




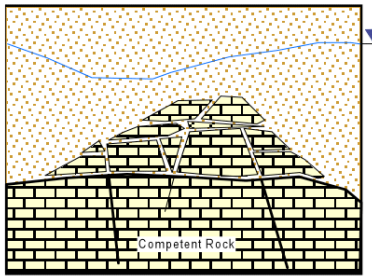
FTC: Conceptual Models

Initial Geophysical Interpretations

Data from Sub-Area F



Interpreted Section:

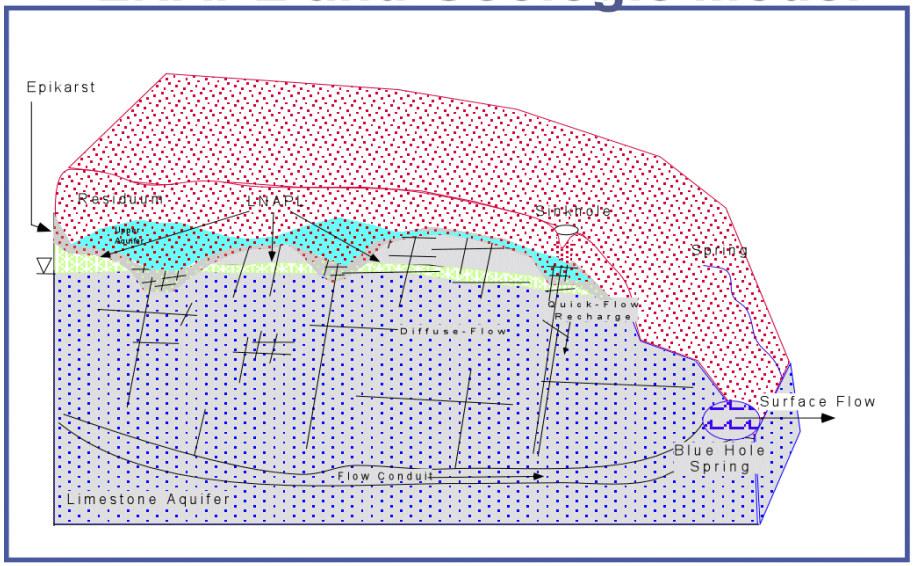


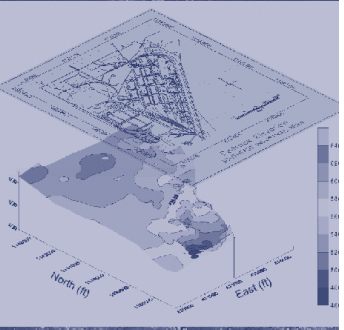
The water table is lower within residuum above weathered bedrock highs.

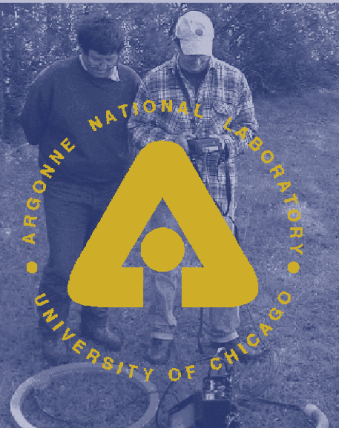
Weathered bedrock (epikarst) has a high electrical-resistivity and low seismic-velocity

Competent section of bedrock refracts a dominant component of seismic energy.

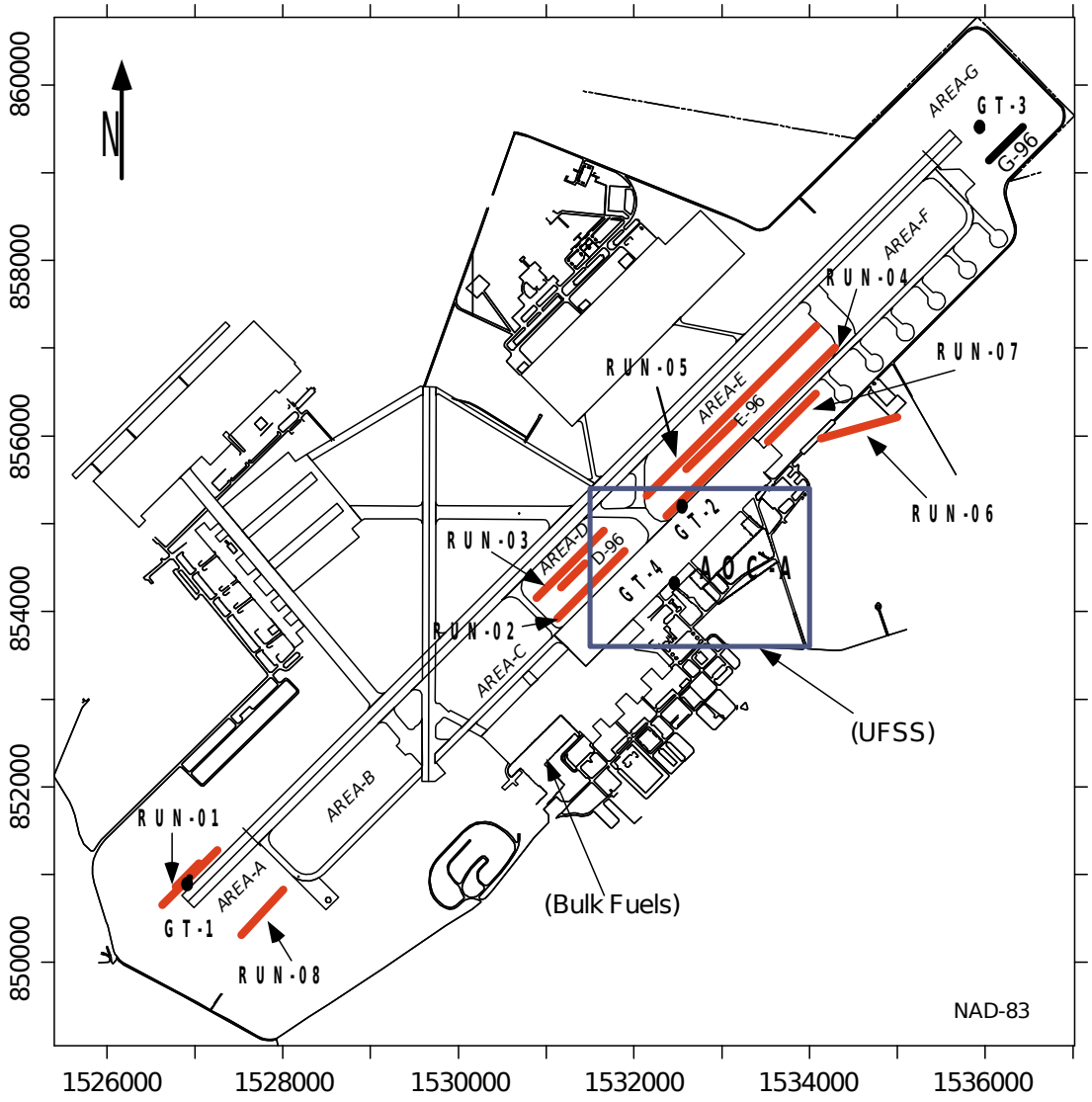
LNAPL and Geologic Model

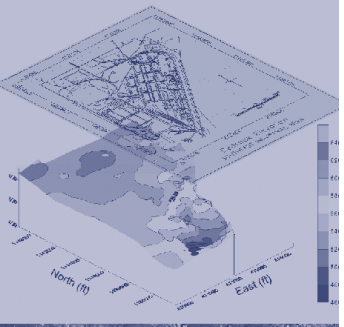


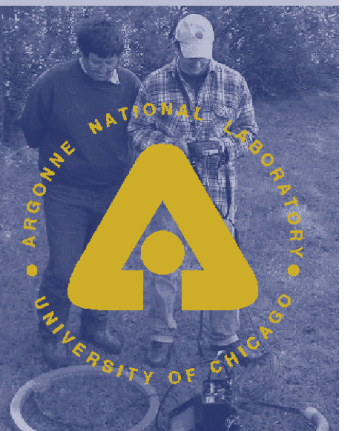




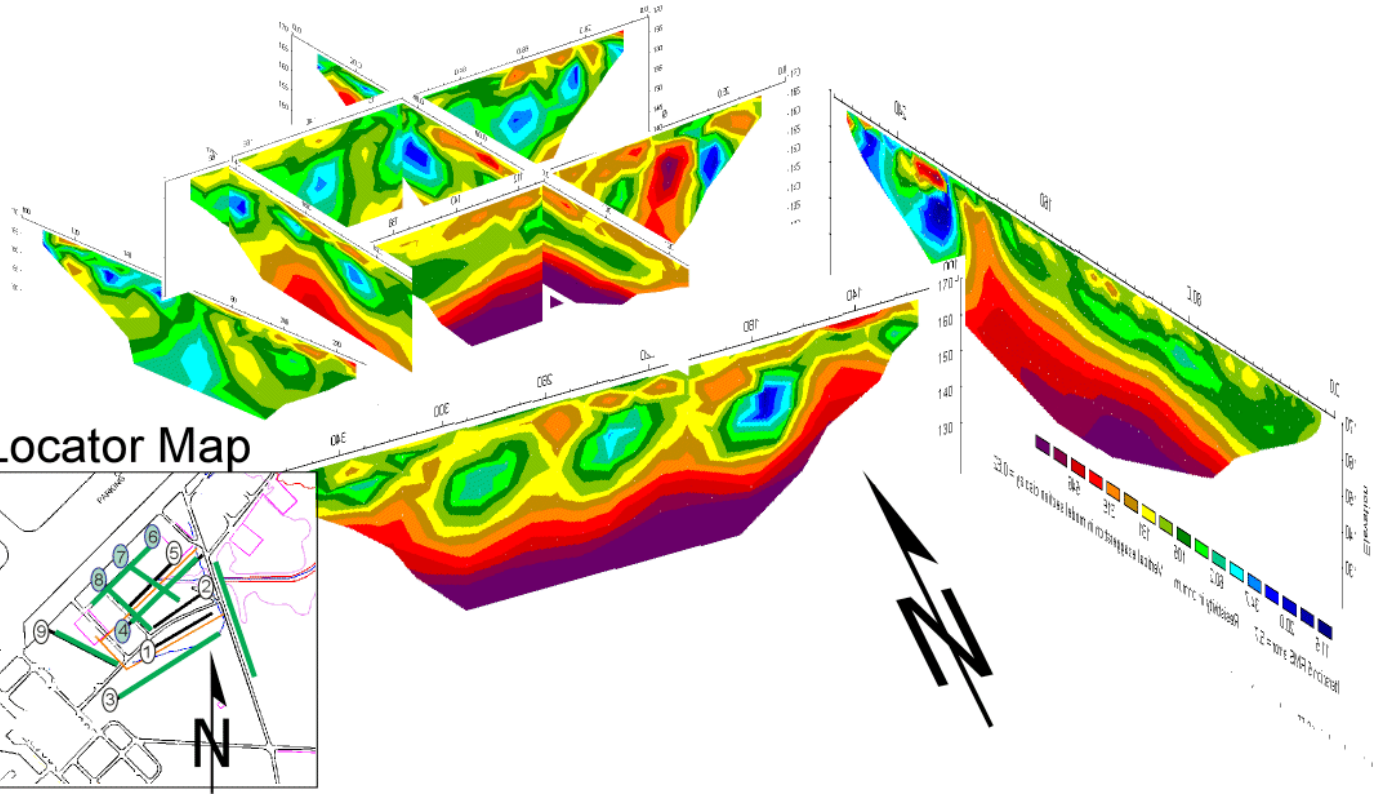
Campbell Army Airfield

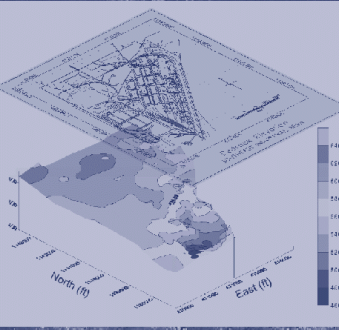


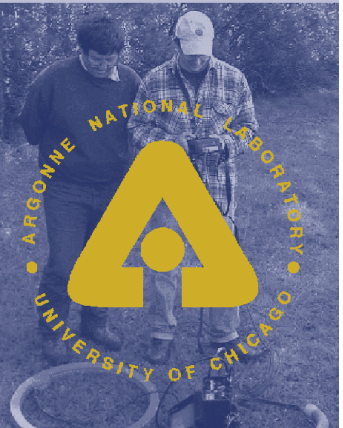




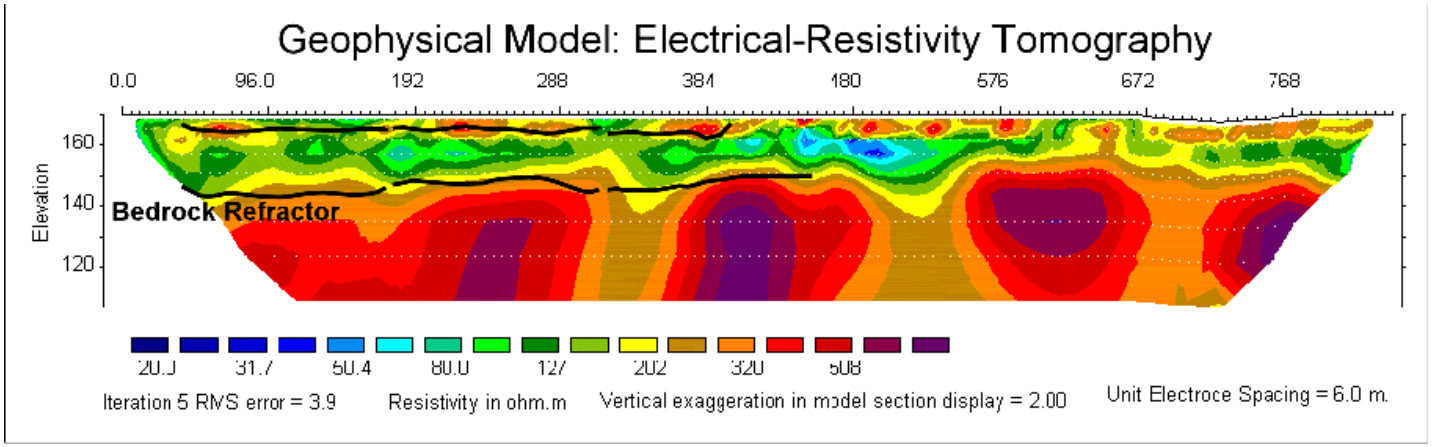
FTC: Resistivity Profiles

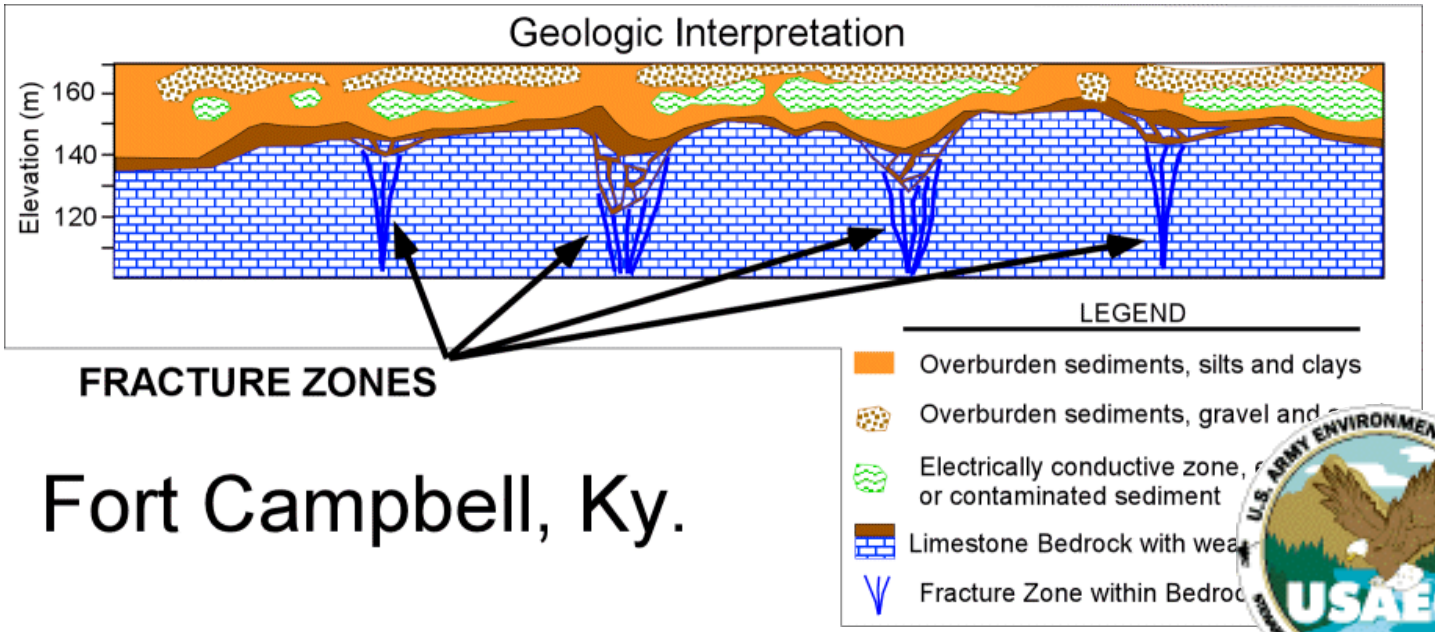




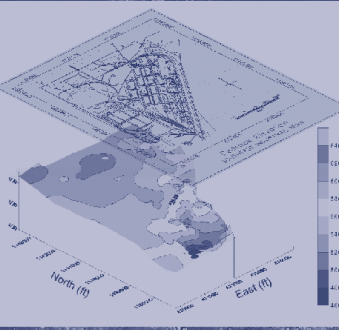


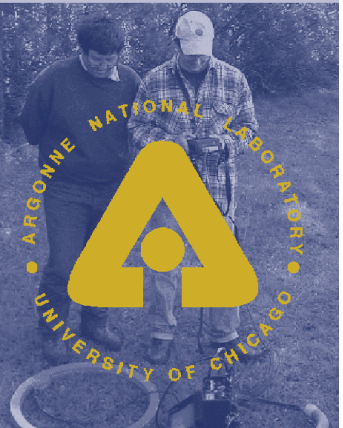
FTC: Resistivity Model



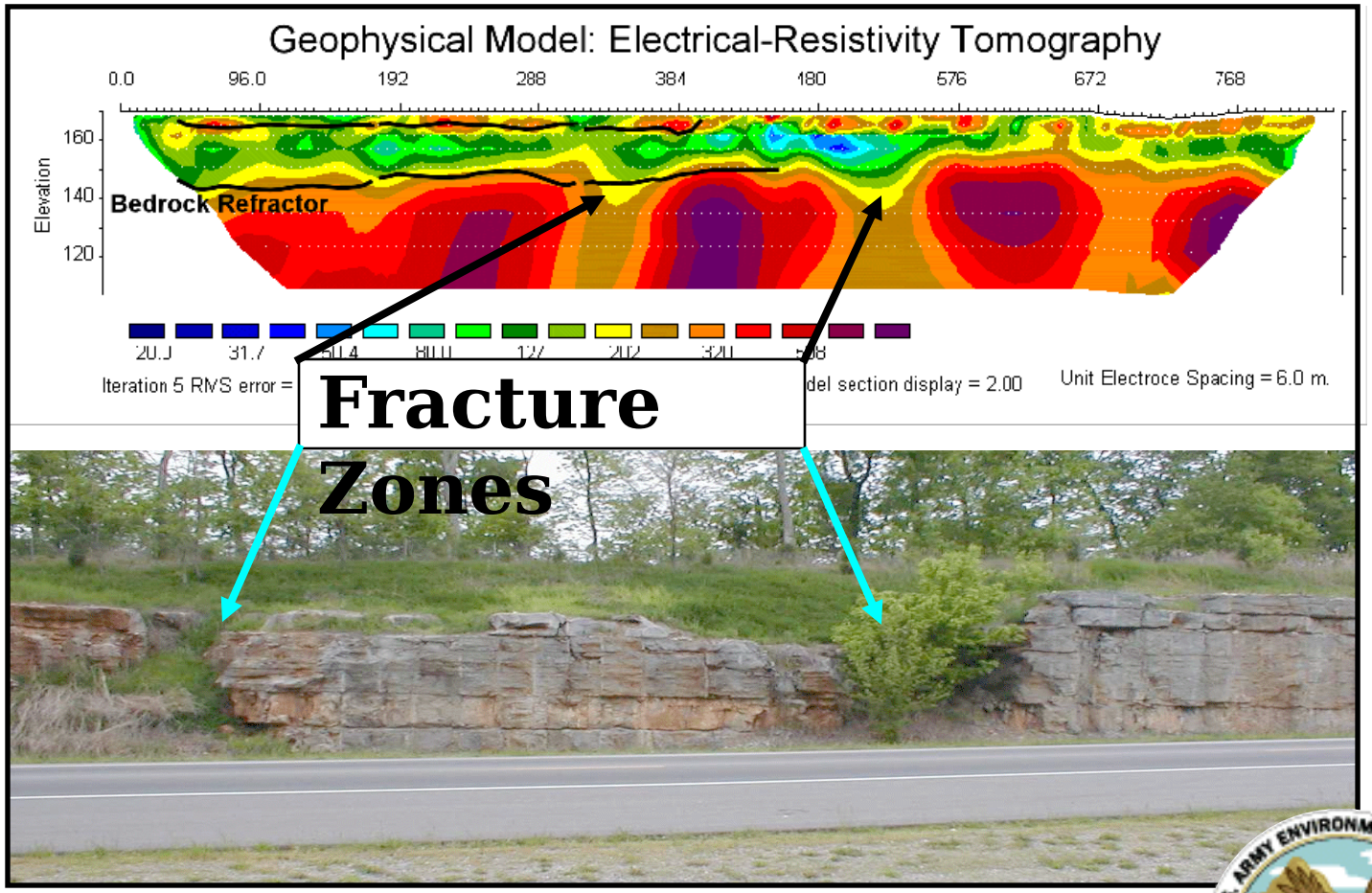


Fort Campbell, Ky.

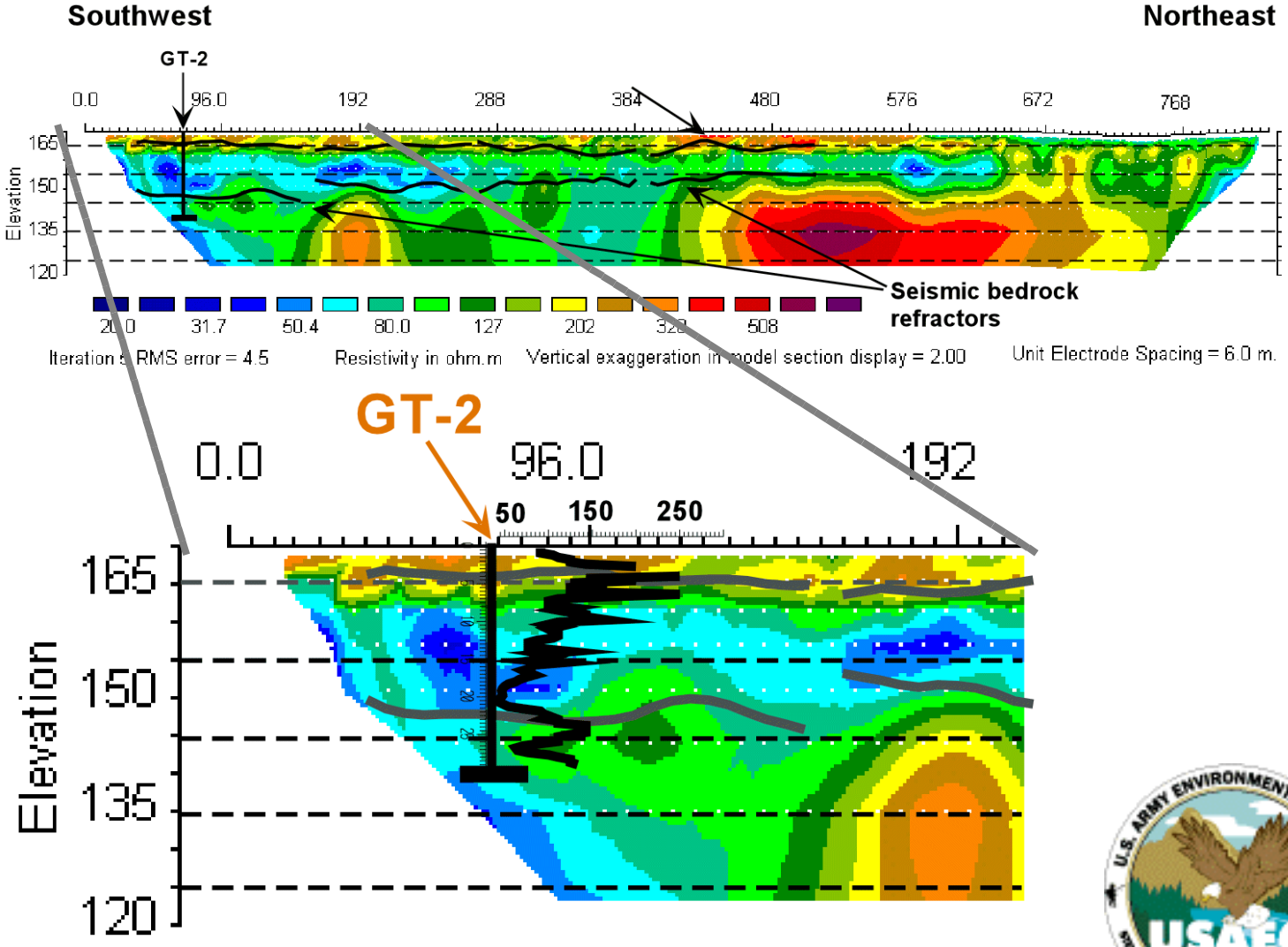




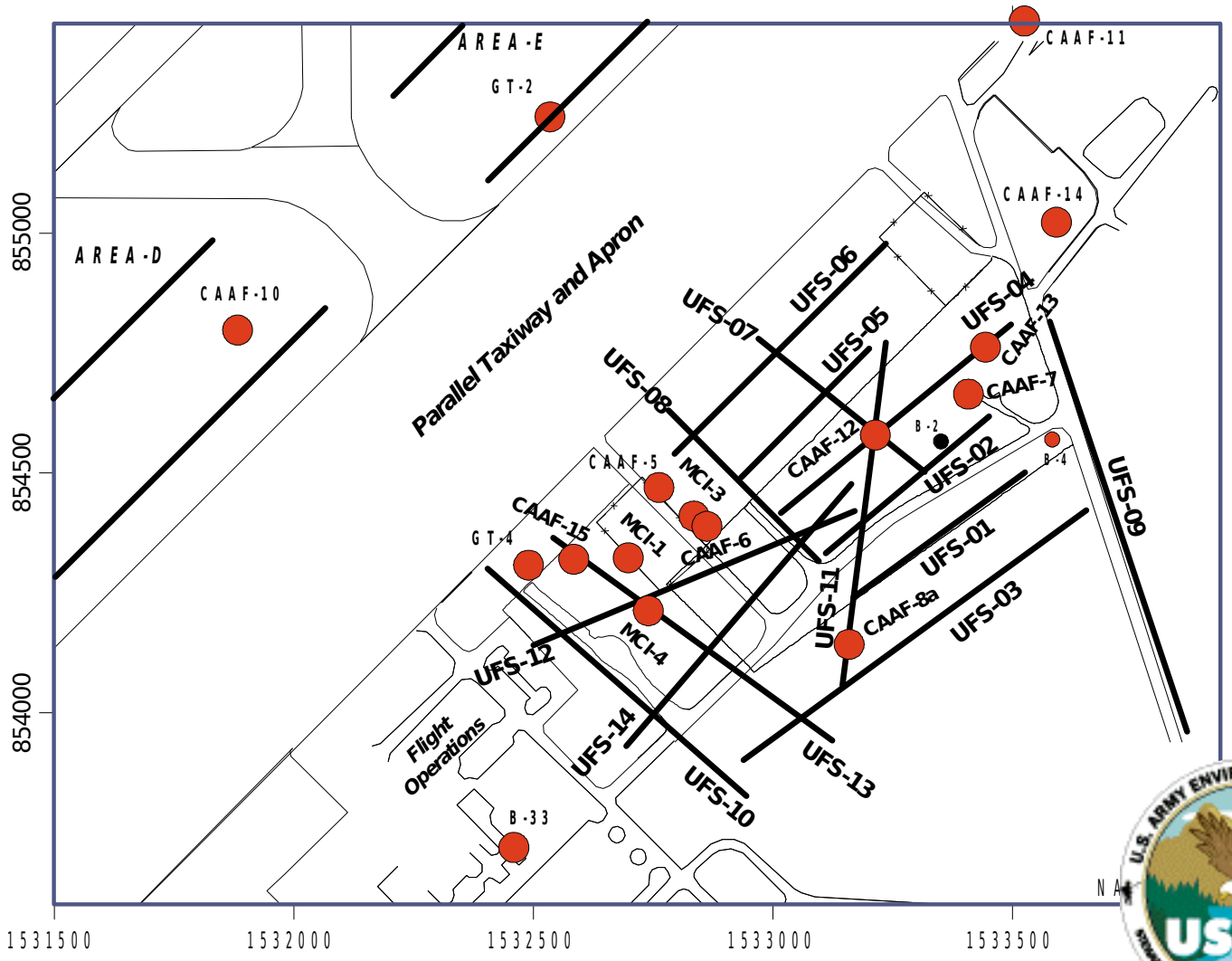
Resistivity Interpretation



Resistivity Ground Truth



CAAF: UFFS


AREA-E
GT-2
CAAF-11
AREA-D
CAAF-10
CAAF-14
Parallel Taxiway and Apron
UFS-07
UFS-06
UFS-05
UFS-04
UFS-08
CAAF-13
CAAF-7
CAAF-12
B-2
B-4
UFS-02
UFS-09
CAAF-5
MCI-3
CAAF-15
MCI-1
CAAF-6
GT-4
UFS-01
UFS-11
CAAF-8a
UFS-03
MCI-4
UFS-12
Flight Operations
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B-33
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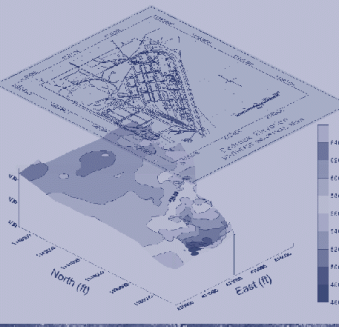
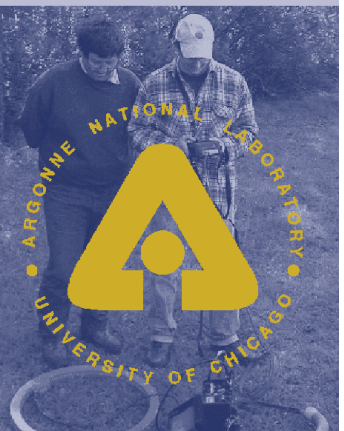
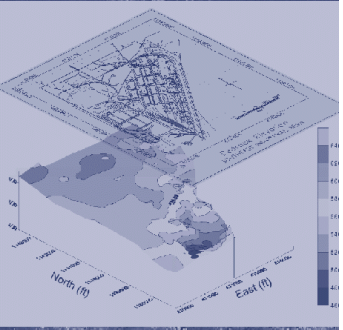
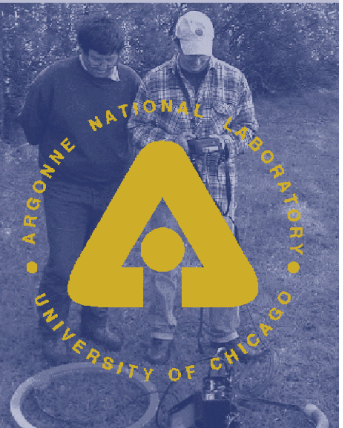
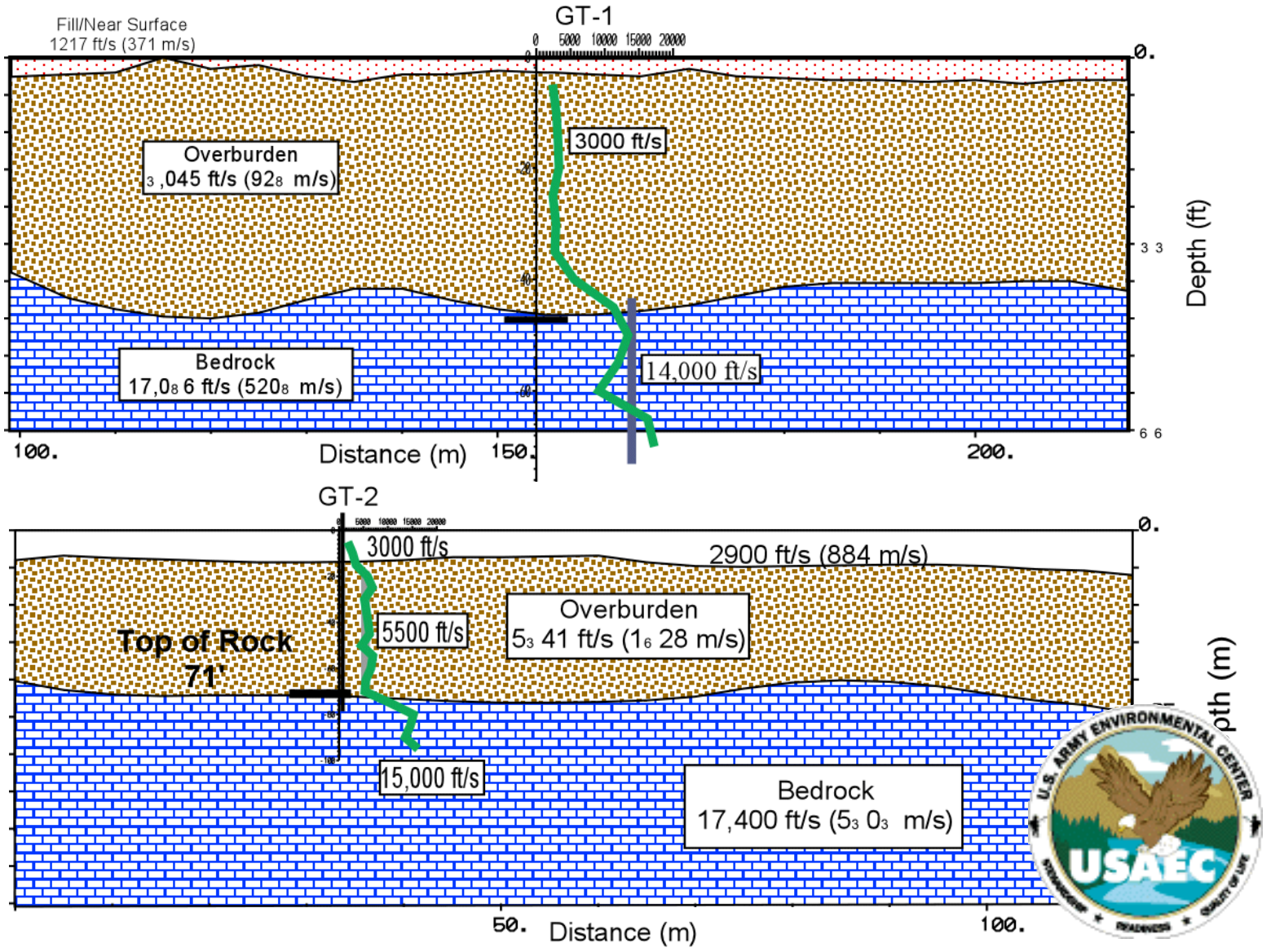

North (ft)
East (ft)

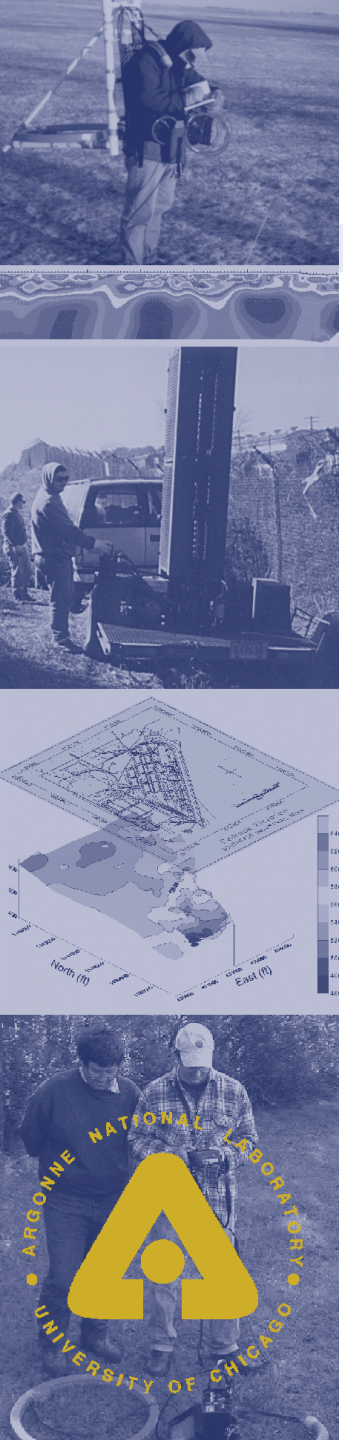

ARGONNE NATIONAL LABORATORY
UNIVERSITY OF CHICAGO



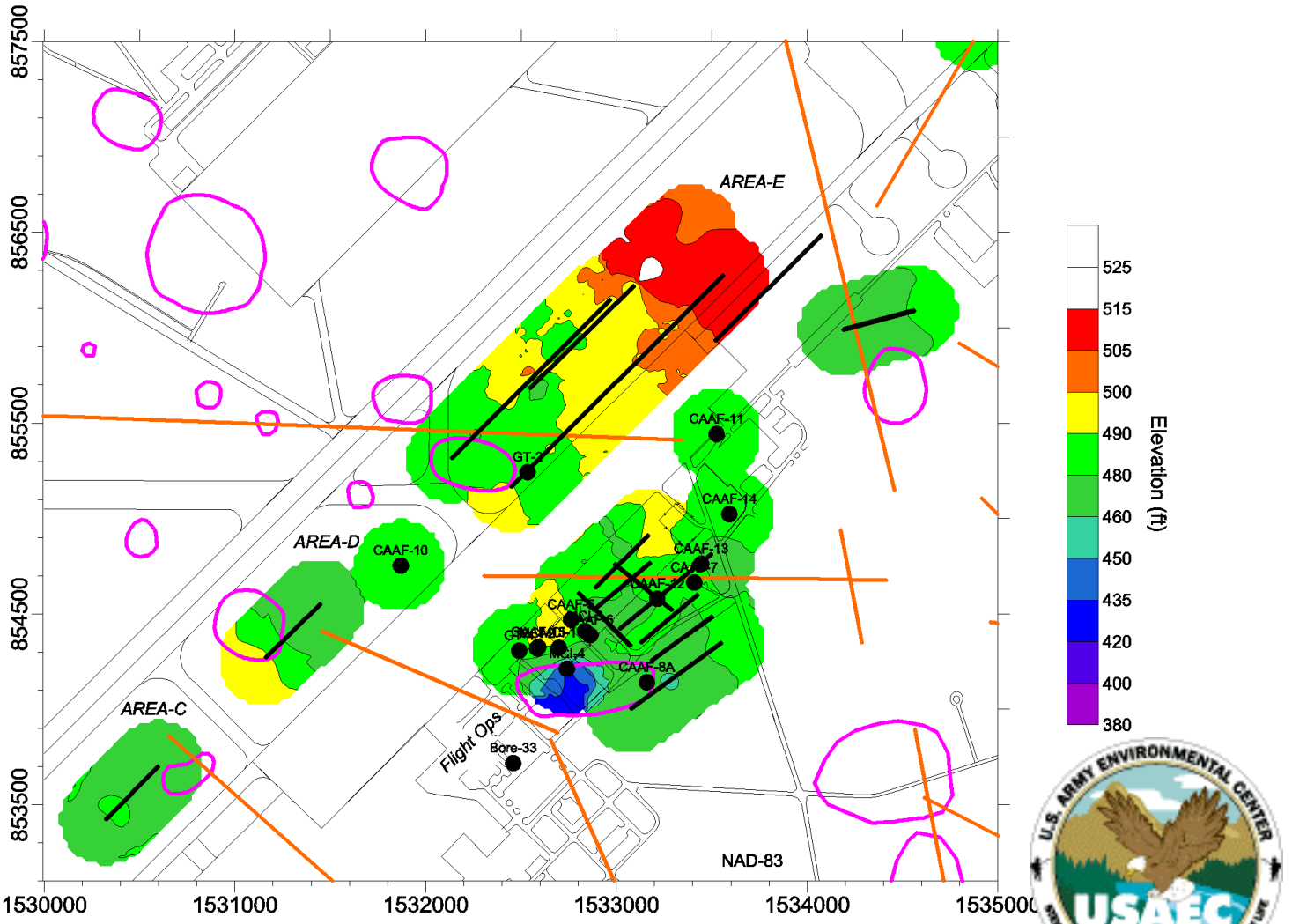


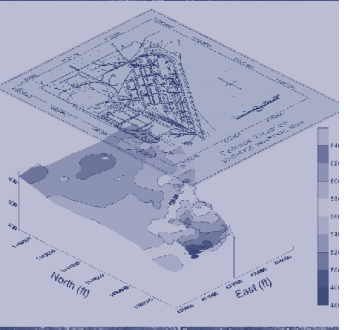
CAAF: Refraction Models

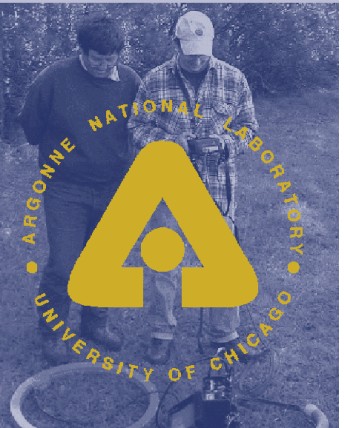




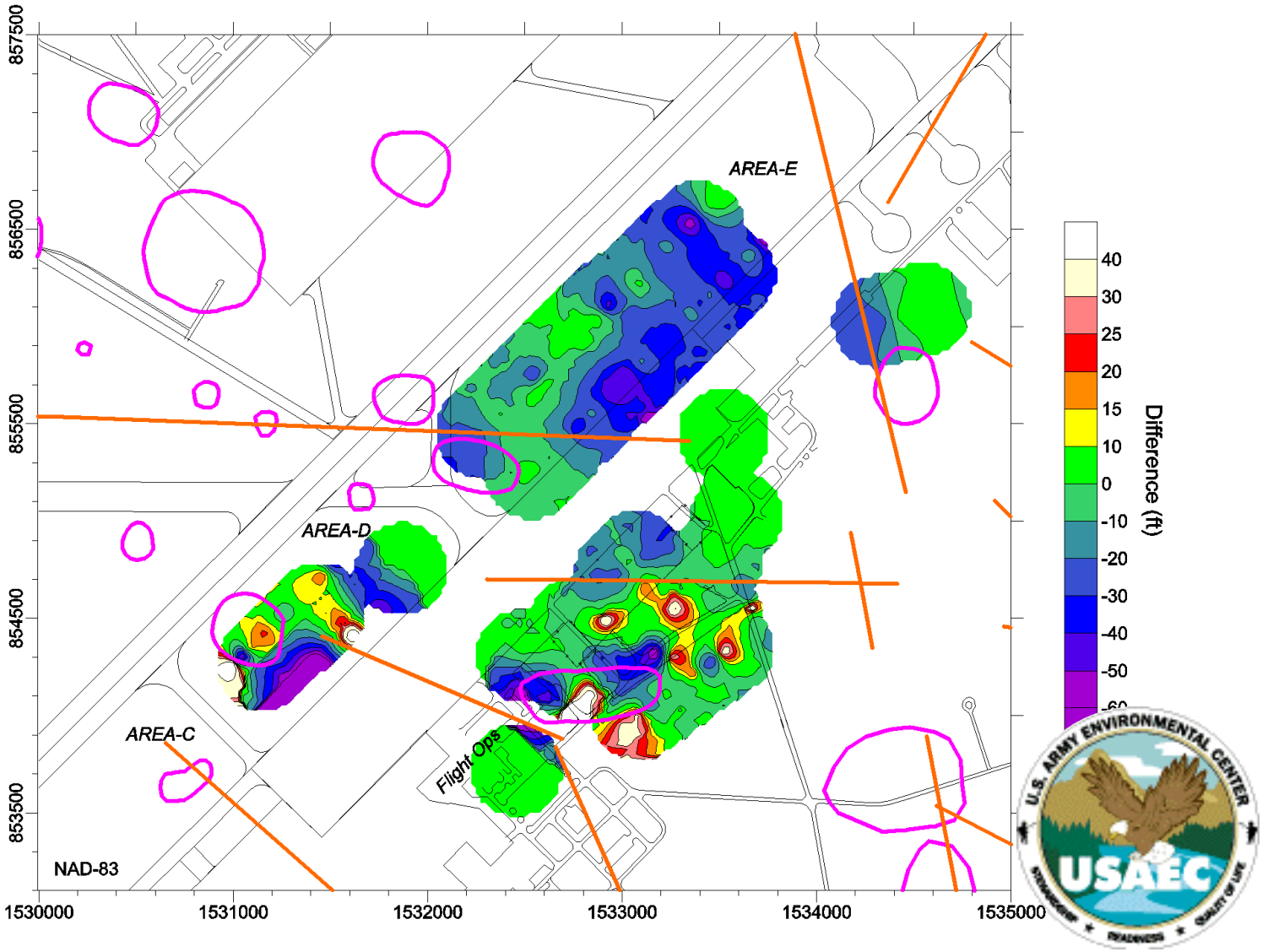
CAAF: Bedrock Surface

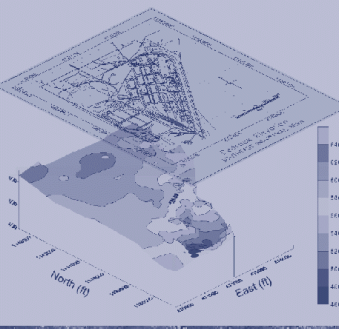


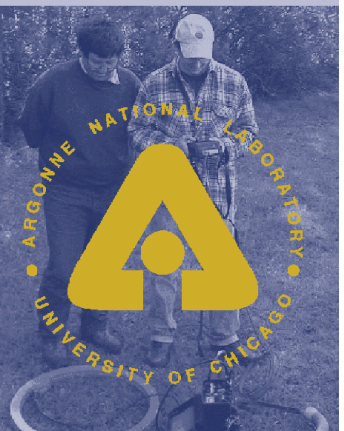




CAAF: Difference Map







Conclusions

- **Map Bedrock Lows/Highs**
- **Map Potential Weak Zones**
- **Overcome Noisy Background**